

IN THE DRAWINGS

Attached are four (4) replacement sheets of drawings that are intended to replace the drawings submitted with the application.

Figs. 1-5 have been amended to add reference number 51 to identify the connection between the integrated circuit device 3 and substrate 7.

REMARKS

Claims 1, 11, 12, and 13 are amended and claims 25-30 are added by this amendment. Claims 1-17 and 25-30 will be pending upon entry of this amendment.

The drawings and specification have been amended herein to more fully describe the embodiment shown in the drawings. No new matter is believed to be added by these amendments.

The following remarks are responsive to the Office action mailed October 6, 2004.

I. Objection to the Drawings

Applicant has amended Figs. 1-5 to add reference number 51 to identify the connection between the integrated circuit device 3 and substrate 7.

The Examiner rejected the drawings under 37 CFR 1.83(a) as not showing every feature of the invention as specified in claims 1 and 12. As set forth in the discussion below, applicant respectfully asserts that the recitations of amended claims 1 and 12, as well as all other pending claims, are adequately shown in the drawings.

Claims 1 and 12 are generally directed to the feature of the present invention wherein at least one adhesive body is positioned between the integrated circuit device and the substrate to form a connection between the circuit device and the substrate. As noted in the specification, the adhesive bodies 45 form connections 51 between the integrated circuit device and the substrate. In the amended drawings, the connections are indicated generally by the reference numeral 51 and are located between the integrated circuit device and the substrate.

Accordingly, the requirements of claims 1 and 12 reciting that the adhesive body (or bodies) is positioned between the integrated circuit device and the substrate to form a connection

between the circuit device and the substrate are believed to be shown in the drawings.

Accordingly, the drawings are submitted to adequately show the features of these claims.

II. Response to Objection to the Specification and Claim  
Rejections under 35 U.S.C. Section 112

On page 3 of the Office action, claims 1 and 12 are rejected under 23 U.S.C. Section 112 as being indefinite for failing to point out and distinctly claim the invention. In particular, the Examiner takes the position that the term "mechanical connection" is unclear and not shown in the drawings.

Applicant has amended claims 1 and 12 to remove the term "mechanical", so that the claims now specify that the at least one adhesive body forms a connection between the circuit device and the substrate. Further, as noted above, the drawings are amended to add the reference number 51 to indicate an exemplary "connection" referred to in the claims. Similar clarifying amendments have been made to the written specification. No new matter is added.

Accordingly, applicant submits that claims 1 and 12, as amended, fully meet the requirements of 35 U.S.C. §112. In the event that the Examiner feels that this response is not adequate to overcome the rejection, the undersigned requests a phone call from the Examiner prior to the mailing of any further correspondence by the Office.

III. Response to Rejection of Claims

A. General Remarks

The present invention is directed to an electrical circuit assembly having an integrated circuit device connected to a substrate via a releasable connection formed by at least one adhesive body. The connection is releasable in that each such

body can be heated to release the mechanical holding force attaching the integrated circuit device to the substrate. As a result, the integrated circuit device can be readily removed from the substrate for repair, and either reattached after completion of the repairs, or replaced with a new integrated circuit device.

**B. Claims 1-11, 25, and 26**

Claim 1, as amended, is directed to an assembly comprising:

- a substrate;

- an integrated circuit device adapted to be electrically and mechanically attached to the substrate and having a bottom surface and a side surface;

- electrically conductive connecting elements between the device and the substrate that electrically connect the device and the substrate; and

- at least one adhesive body positioned between the integrated circuit device and the substrate to form a connection between the circuit device and the substrate, the at least one adhesive body being in contact with said bottom surface and said side surface of the integrated circuit device;

- said at least one adhesive body comprising a non-thermosetting material which, when heated, releases said connection to allow removal of the circuit device from the substrate.

Claim 1 is submitted as nonobvious and patentable over the prior art of record, including in particular U.S. Patent No. 6,642,626 (Park) and U.S. Patent Application Publication No. 2003/0170450 (Stewart et al.).

Park discloses a ball grid array IC package having a semiconductor chip 210, hourglass type conductive balls 215 electrically connecting the chip to a substrate 200, and polymer

balls 230 formed on the chip for maintaining the spacing between the chip and the substrate. The polymer balls are expandable and are connected to the chip 210 by a layer of adhesive 232. As shown in Figs. 5A-7, each polymer ball 230 is charged with fluid (e.g., air, gas, water, oil) using an injector 240 to expand the volume of the ball. When the package is heated during assembly (see Figs. 3A-3D), the polymer balls 230 expand and contact the substrate 200 to maintain a predetermined interval between the chip 210 and the substrate and allow the solder balls 215 to form an hourglass shape. When the package is no longer heated, the balls 230 contract and may be removed.

Park fails to show or suggest an assembly as set forth in claim 1, that is, an assembly having at least one adhesive body positioned between the integrated circuit device and the substrate to form a connection between the circuit device and the substrate, the at least one adhesive body being in contact with the bottom surface and side surface of the integrated circuit device and comprising a non-thermosetting material which, when heated, releases the connection to allow removal of the circuit device from the substrate. In contrast, Park teaches that each polymer ball 230 is charged with fluid (e.g., air, gas, water, oil) using an injector 240 to expand the volume of the ball so that the polymer balls expand and contact the substrate 200 to maintain a predetermined interval between the chip 210 and the substrate. In addition, the polymer balls 230 are not made of an adhesive material and the balls do not contact a bottom surface and side surface of the chip 210. Nothing in the disclosure of Park teaches an adhesive body made of a non-thermosetting material that forms a connection between the circuit device and the substrate or an adhesive body in contact with the bottom surface and side surface of the circuit device.

For these reasons, claim 1 is unanticipated and patentable over Park.

Stewart et al. disclose the use of a thermoplastic adhesive to attach a surface mount electronic device to a printed circuit board instead of conventional thermosetting underfill. As shown in Fig. 8, the surface mount electronic device (e.g., BGA 1) comprises an integrated circuit 4 mounted on a connecting substrate 3. The BGA 1 is electrically connected to the printed circuit board 2 by solder balls 5. The thermoplastic adhesive 7, 9 may be attached to the bottom surface of the connecting substrate 3 (Fig. 8) and/or the top surface of the circuit board 2 (Fig. 9). Fig. 8 illustrates that the thermoplastic adhesive 7 has a height 10 less than an assembly gap width 9 between the connecting substrate 3 and the circuit board 2 prior to reflow of the solder balls 5. Figs. 10 and 11 show the various shapes of the joints 1a, 1b, 2, 3, 4, and 5 formed after heating the thermoplastic adhesive.

Stewart et al. also fail to show or suggest an assembly as set forth in claim 1 of the present application. As shown in Figs. 10 and 11 of this reference, the joint formed by the thermoplastic adhesive of Stewart et al. is in contact with the bottom surface of the integrated circuit device and not the side surface of the device. In contrast, the invention of claim 1 recites that the adhesive body is in contact with the bottom surface and the side surface of the integrated circuit device and forms a connection between the circuit device and the substrate. The importance of the positioning of the adhesive bodies is noted at paragraph 20 of the present application. In particular, positioning the adhesive bodies in contact with the bottom surface and at least one side surface of the circuit device enhances the mechanical holding force of the connection. Nothing in the disclosure of Stewart et al., or the other references of record, shows or suggests an adhesive body of a non-thermosetting material contacting a bottom surface and side surface of the integrated circuit device to form a connection therebetween.

For these reasons, claim 1 is unanticipated and patentable over Stewart et al. and the other references of record.

Claim 2-11, 25, and 26 depend directly or indirectly from claim 1 and are submitted as patentable for the same reasons.

New claim 25 depends from claim 1 and recites that the bottom surface of the integrated circuit device is spaced apart from the substrate by a distance and that the adhesive body comprises a spherical body having a diameter greater than the distance between the bottom surface of the integrated circuit device and the substrate. Accordingly, claim 25 is submitted as unanticipated by and patentable over Stewart et al. for this additional reason.

New claim 26 depends from claim 25 and recites that the spherical body has a diameter approximately 1.5 times the distance between the bottom surface of the integrated circuit device and the substrate. Accordingly, claim 26 is submitted as unanticipated by and patentable over Stewart et al. for this additional reason.

**C. Claims 12-17, 27 and 28**

Claim 12 is similar in scope as claim 1 but recites that the assembly comprises at least two adhesive bodies. Specifically, claim 12 is directed to an assembly comprising:

- a substrate;

- an integrated circuit device adapted to be electrically and mechanically attached to the substrate and having a bottom surface and a side surface;

- electrically conductive connecting elements between the device and the substrate that electrically connect the device and the substrate; and

- at least two adhesive bodies comprising a non-thermosetting material positioned between the integrated circuit device and the substrate to form a releasable

connection between the circuit device and the substrate, the at least two adhesive bodies being in contact with the bottom surface and side surface of the integrated circuit device.

As discussed above in regard to claim 1, Park and Stewart et al. fail to show or suggest an assembly having even one adhesive body, much less two such bodies, positioned between the integrated circuit device and the substrate to form a connection between the circuit device and the substrate, the adhesive bodies being in contact with the bottom surface and side surface of the integrated circuit device and comprising a non-thermosetting material which, when heated, releases the connection to allow removal of the circuit device from the substrate. Accordingly, claim 12 is submitted as nonobvious and patentable over Stewart et al., Park, and the other references of record.

Claim 13-17, 27, and 28 depend directly or indirectly from claim 12 and are submitted as patentable for the same reasons.

New claim 27 depends from claim 12 and recites that the bottom surface of the integrated circuit device is spaced apart from the substrate by a distance and that the adhesive bodies comprise a spherical body having a diameter greater than the distance between the bottom surface of the integrated circuit device and the substrate. Accordingly, claim 27 is submitted as unanticipated by and patentable over the references of record for this additional reason.

New claim 28 depends from claim 27 and recites that the spherical bodies have a diameter approximately 1.5 times the distance between the bottom surface of the integrated circuit device and the substrate. Accordingly, claim 28 is submitted as unanticipated by and patentable over the references of record for this additional reason.



**D. New Claims 29 and 30**

New claim 29 is submitted as patentable over the prior art of record, including Stewart et al., Park, and the other references of record, in that none of the references show or suggest an assembly having the features recited in claim 29, namely:

- i) a substrate;
- ii) an integrated circuit device adapted to be electrically and mechanically attached to the substrate and having a bottom surface and a side surface, the bottom surface being spaced apart from the substrate by a distance;
- iii) electrically conductive connecting elements between the device and the substrate that electrically connect the device and the substrate; and
- iv) at least one adhesive body positioned between the integrated circuit device and the substrate to form a connection between the circuit device and the substrate, the at least one adhesive body comprising a spherical body having a diameter greater than the distance between the bottom surface of the integrated circuit device and the substrate and being in contact with the bottom surface of the integrated circuit device and the side surface of the integrated circuit device;
- v) said at least one adhesive body comprising a non-thermosetting material which, when heated, releases said connection to allow removal of the circuit device from the substrate.

It should be noted that Park and Stewart et al. fail to teach an assembly comprising a spherical adhesive body having a diameter greater than the distance between the integrated circuit device and the substrate and being in contact with the bottom surface of the integrated circuit device and the side surface of

the integrated circuit device. Therefore, claim 29 is submitted as allowable over the prior art.

Claim 30 depends from claim 29 and recites that the spherical body has a diameter approximately 1.5 times the distance between the bottom surface of the integrated circuit device and the substrate. Accordingly, claim 30 is submitted as patentable over the prior art of record for this additional reason.

IV. Conclusion

In view of the foregoing, reconsideration and allowance of claims 1-17 and 25-30 is respectfully requested.

No fee is believed to be due for the submission of this response. The Commissioner is hereby authorized to charge any fee deficiency or credit any overpayment to Deposit Account No. 19-1345 in the name of Senniger Powers

Respectfully submitted,



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